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Sub-epidermal rusts.

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(WITH PLATE XV.)

During the past year I have made a structural study of the teleutosporic stage of *Puccinia coronata* Cda. and *P. rubigo-vera* DC. upon different hosts with the hope that careful work would reveal, among other things, some differentiating structural characteristics. To be of worth, such defining marks must be constant through all variations of an individual species. Though the work was not wanting in interest, it may be well to say that, with regard to the discovery of such diagnostic features, my observations have been essentially negative; for structural variations which upon some hosts were often quite marked were upon others either absent or so slight as to be of no comparative value.

In most species of Uredineæ, the teleutospores break through the epidermis of the nourishing plant (fig. 1), but in both the species mentioned they reach maturity in the matrix or sorus without rupturing the enclosing epidermis (fig. 2), a condition which is typical of a number of other species, which, for convenience in this paper, have been termed "sub-epidermal."[1]

These species, because of their similarity of development, present many common peculiarities of form and structure. In some cases, as P. coronata and P. rubigo-vera, species grade the one into the other so closely as to nearly defy separation upon a structural basis. Upon examining type spores of these two forms, one immediately notices the striking differences in the apices, P. coronata being possessed of a crown of flame-yellow finger-form projections, while those of P. rubigo-vera are truncate (fig. 13 and 12, *a* and *b*). These, however, are not constant characteristics. Some specimens of P. rubigo-vera produce teleutospores which show a strong tendency to form points, and many specimens of P. coro-

[1] P. scirpi DC. †; P. elcocharidis Arth. †; P. striatula Peck †; P. vulpina Schroet. †; P. anemones-virginianæ Schw. †; P. galiorum Lk.; P. sessilis Schneider; P. obscura Schroet. †; P. phalaridis Plow.; P. poarum Nielson. The species marked (†) were studied in connection with this paper.

nata develop spores but few of which show any signs of the, digitate processes.

Forming within the host as these spores do, they are under constant pressure because of their own growth and the resistance of the host tissues; hence it is that we may expect to find a large number of malformations. In all the sub-epidermal species studied one-celled forms (figs. 12 *f*, 13 *g*) were found aggregated in the same pustules with the regularly formed teleutospores, but cross sections, vertical to the surface of host, always found them to be located around the borders of the sorus or in places in which an upward expansion was not permitted.

As I did not in any case observe mature spores of this form in portions of the sorus in which there would be freedom of expansion, and as such spores are often found in sori of P. graminis and other eruptive species, which for some reason have failed to tear away the epidermal covering, I take it that these spores are simply dwarfed forms due, perhaps, to a lack of nourishment and excessive pressure at the proper time for the formation of the cross septum. According to this view of formation the term "mesospore"[2] used either according to Sorauer or Dietel is not applicable to these anomalies as found in the species studied (foot-note 1).

As the number in which they appear in relation to the perfect spores is exceedingly variable, not only upon different hosts but in different pustules on the same host, I deem it more probable that their occurrence in these species is due more essentially to local conditions of development than to any hereditary tendency.[3] Certain it is that pressure within the crowded sorus is capable of producing an almost unlimited number of irregularities in the spore forms. Such forms as the one seen at *f*, fig. 13, are always to be found in the borders of the sori, the curvature being due to continued pressure exerted by more internally forming spores. Furthermore, the typical spores of a species are found to arise from the central area of the spore-bed, the position in which the spores

[2] Winter—Rabenhorst's Kryptogamen Flora, Pilze, vol. i, p. 133.

Sorauer—"Between the uredo and teleutospores one often observes intermediate forms (mesospores) which are really to be considered as simple transition forms." Pflanzenkrankheiten, ed. 2, vol. ii, p. 213.

Dietel—"These spores (mesospores) are not medial between two other spore forms; but the species in which they occur stand themselves intermediate between the two genera, Uromyces and Puccinia." Morphologie und Biologie der Uredineen, p. 6; Botanisches Centralblatt, vol. xxxii, 1887.

[3] This is not given as an explanation of the production of the mesospores as found in such species as *P. vexans* Farlow and *P. sporoboli* Arth., which I have not studied.

are least subjected to irregularites of resistance. In every case the pressure is due to enlargement of the spore during growth, while the adjacent spores and the surrounding tissues, simply through resistance, constitute the moulds which shape the irregularities.

These irregularities in the spores are of two distinct natures, those which arise from an actual moulding of the spore form due to turgidity of growth and inequalities of external resistance and those which are due to an innate molecular condition of the spore wall which permits of inequalities of extension. The latter mode of formation is of an hereditary nature, due to peculiarities of molecular structure effected by the protoplasm of the species in which it occurs: the first is an accident of development.

Herein lies what I take to be the chief structural difference between the species P. coronata and P. rubigo-vera. While the digitate processes upon the spores of the first are normal to the particular parts of the spore membrane, the irregularities in the contour of the spores of the latter are accidental, depending for the particular forms upon the moulding of the young spores and a subsequent thickening of the cell walls.

That the points upon the spores of P. coronata have no constant regularity of form, number or position, does not invalidate this idea. Certain portions of the spore membrane are possessed of greater powers of extension, perhaps by imbibition, and they expand in the direction in which there is least resistance. These points are always to be seen in vertical sections of the sorus extending into depressions in the epidermis and into interstices between the apices of the spores. The position of the points with reference to the spores, as seen from above, is shown in fig. 5.

The Stroma.—In those species in which the teleutospores are truly sub-epidermal during their whole development, they are not formed upon the same spore bed as the uredospores, which necessarily rupture the epidermis, but are aggregated in a new spot under the uninjured epidermis. It is in the completion of this new sorus that the fungus displays a high degree of parasitism in that, when mature, the mat of fungal tissue which surrounds the spores becomes essentially a part of the host. The fungal hyphæ ramify in the host tissues, principally by way of the intercellular spaces (figs. 2, 3 and 4). When a fruiting spot is formed two or more hyphal branches coalesce, as seen in fig. 3, in an intercellular space lying be-

tween the epidermis and the hypodermal layer. This is the beginning of the *stroma*[1] (hymenium, sporenlager, spore-bed, etc.), a mass of fused fungal hyphæ from which the spores arise.

In section, the mature stroma gives the appearance of a regular tissue displaying many large cell-like openings often much larger than the diameter of the ordinary hypha, due to the interstices between uniting filaments and the solution of some of the uniting walls (figs. 2 *b* and 11 *c*).

The fungal filaments not only have the power of uniting themselves with the cell walls of the host by fusion, but probably by the secretion of an unorganized ferment,[2] can penetrate, pass through or wholly dissolve them. Hence it is that the hypodermal host tissues are always to be found closely united (fused) with the stroma and are not distorted, though the pustule, since its formation, has expanded greatly. This quality of fusion is most noticeable in the so-called "para physes" which accompany the teleutospores of P. rubigo-vera.[3]

The various descriptions of this species invariably refer to "dark brown paraphyses" intermingled with or surrounding the spores. Burrill also records the same with regard to P. coronata. The bodies are easily found in both species by scraping off the pustules and examining the debris. But their varying tissue-like dimensions, dissimilarity to ordinary paraphyses (compare fig. 6*c* with fig. 7), and the further fact that they are always not only connected at the base with the stroma but also with the epidermis at the top, led me to believe that they could not be paraphyses in the best accepted sense, but were merely vertical extensions of the basal stroma. Furthermore, in all cases in which a microchemical reagent affected these bodies, the action was the same as that for the stroma.

Carefully prepared serial, vertical and tangential sections of the host leaves, passing through the pustules, confirmed the truth of this supposition.

Soon after the coalescence of the filaments which start the new sorus, the young spores appear, developing centrifugally, while the hyphæ which form the spore-bed eat away the host tissues, spread rapidly, and finally enclose the spores on the sides (fig. 2 *b* and *f*), thus, when fused together and with the epidermis at the top, cutting off what may be termed

[1] For the use of the word see Sorauer, Pflanzenkrankheiten ed. 2, vol ii, p. 212. Also Plowright, "British Uredineæ and Ustilagineæ," p. 36.

[2] Vines, Physiology of Plants, p. 191.

[3] Saccardo, Sylloge Fungorum, vol. vii., part 2, p. 625.

a simple sorus. This development is well shown in the structure of the teleuto-pustule of P. anemones-virginianæ, the fusion of the stromal hyphæ often not being so complete as in other species (figs. 8 and 9). In this species the hyphæ are often seen in cross-section between the simple sori, showing that the vertical position taken by the hyphæ, as usually seen, is in a manner an enforced one, consequent upon the development of the sorus.

A further proof that these hyphæ are not different from the ordinary filaments is found in the fact that when not under pressure at the top they continue to elongate (fig. 8 *b*). The much thickened places on the covering of the pustules in this species are due to these same hyphæ which have passed through the epidermis, forming a fused mass, seen in section fig. 10 *c*. In all the sub-epidermal species on glumaceous plants the sori are found between the leaf-veins, becoming confluent in long lines, while the hyphæ which inclose the simple sori fuse to form the intersorial stromata (fig. 2 *c*) which in thick vertical sections of the compound sorus or pustule give the appearance of the intermixing with the spores of the so-called paraphyses of the descriptions. In vertical longitudinal sections of the pustule, these intersorial stromata are found to be formed across the space between the fibro-vascular bundles in great regularity of position. Whether these structures will be seen in vertical cross sections of the rust pustule depends wholly as to whether or not the space between the fibro-vascular bundles is wide enough for the development of two or more simple sori. From this it will be seen that the ordinary rust pustule of the sub-epidermal forms is not a simple structure as it appears from the exterior, but is compounded of many simple sori; and that the structures lying between owe their form and position merely to a crowding and fusing together of the hyphæ which separate the simple sori and are not separate bodies, paraphyses, but simply extensions of the spore-bed (stroma). That they generally appear as seen at *c* fig. 6 is because an optical section can not reveal the cellular structure. Because of the opacity of the walls and the smallness of the cavities, sections which are to make this structure plain must not have a thickness to exceed 10 μ. In cross section the intersorial stromata appear as strips of regular tissue forming a net-work between the fibro-vascular bundles with which they are connected, while the spores fill up the intervening spaces (fig. 11 *c*). The only apparent difference between this fungal tissue and

the host tissues into which it seems to graduate is its reddish brown color and its ability to resist the action of reagents, macerating fluids, etc.

That the teleutospores are sub-epidermal at maturity is apparently because of the fact that before they have become strong enough to rupture and throw off the epidermis the hyphæ which arise on the sides of the young sorus have fused with and hold that covering in place.

EXPLANATION OF PLATE XV.—Fig. 1. Vertical section through teleuto-sorus of *P. graminis* Pers. on leaf sheath of Triticum vulgare; host tissues in cross-section: *a*, epidermis; *b*, teleutospore; *c*, sclerenchyma; *d*, fungal hypha. × 120.

Fig. 2. Vertical transverse section of young compound teleuto-sorus of *P. coronata* Cda. on leaf of Avena sativa, showing the relation of the young spores to the surrounding tissues and the penetration of the host by the fungal hyphæ: *a*, epidermis; *b*, a portion of the spore-bed (stroma) in section; *c*, the same as found between the simple sori, a so-called paraphysis in vertical longitudinal section; *d*, young spores not yet septate; *e*, nearly mature spore; *f*, beginning of stroma which finally encloses the spores. × 350; section 5 μ thick.

Fig. 3. Portion of a vertical longitudinal section of leaf of Avena sativa, showing very early stage of a teleuto-sorus and intercellular hyphæ: *a*, epidermis; *b*, coalescing hyphæ forming the spore-bed; *c*, hypodermal cell.

Fig. 4. Tangential section of leaf of Avena sativa in hypodermal region passing through the young spore-beds: *a*, hypodermal cells; *b*, basal portions of young spores; *c*, intercellular hyphæ; *d*, hyphæ fused with cell walls and partly in section. Section 5 μ thick; × 350.

Fig. 5. Apices of four mature spores of *P. coronata* Cda. as seen from above, showing form and position of digitate processes. × 680.

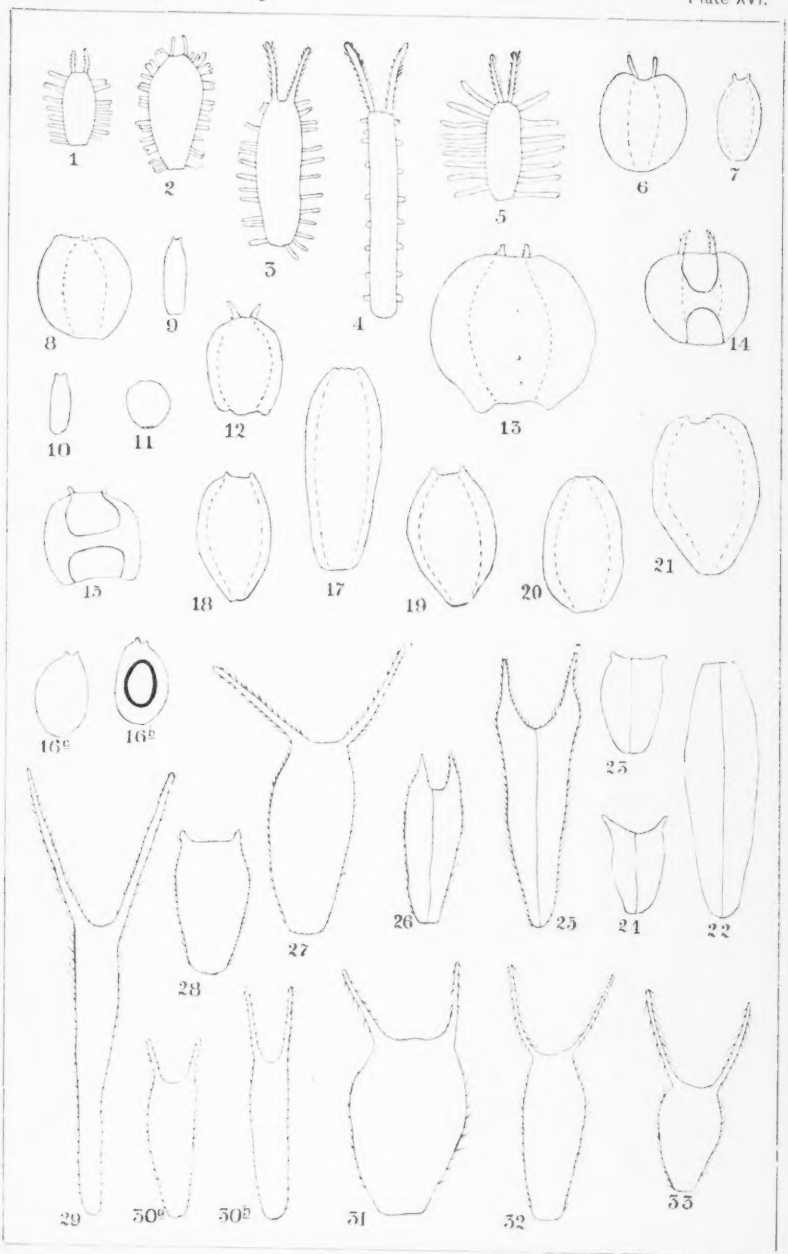
Fig. 6. Spore and *so called paraphysis* in situ; typical form from *P. rubigo-vera* DC. on Hordeum jubatum: *a*, epidermis; *b*, teleutospore; *c*, the "*paraphysis*" (stroma). × 350.

Fig. 7. Two paraphyses from uredo-sorus of *Phragmidium rosæ-alpinæ* DC. × 350.

Fig. 8. Portion of a compound sorus of *P. anemones-virginianæ* Schw. on Anemone patens, showing intersorial stroma in section, *c-a*; *b*, hypha passing over apices of spores; *d*, hypha beneath the spore-bed; stroma and epidermis fused at *a*. × 200.

Fig. 9. Same as fig. 8; hyphæ which form the intersorial stroma not completely fused: *a*, epidermis; *b*, hypha; *c*, spore. × 200.

Fig. 10. Left corner of sorus of P. anemones-virginianæ: *a*, epidermis of host; *b*, hypha partly fused with epidermis; *c*, coalescing hyphæ; *d*, spore. × 200.



ROSE on COREOPSIS.

Fig. 11. Tangential section of leaf of Avena sativa cutting a compound sorus of P. coronata midway between spore-bed and epidermis: *a*, teleutospores in cross section; *b*, cells of fibro vascular bundle; *c*, intersorial stroma in cross-section. Section 5 μ thick. $\times$ 350.

Fig. 12. Teleutospores of P. rubigo-vera on Triticum vulgare from Ellis' "North American Fungi" No. 1471, showing variations in size and form upon the same host: *a*, *b*, type spores; *c* and *d*, spores bearing short points at apices; *f*, a one celled spore. $\times$ 350.

Fig. 13. Teleutospores of *P. coronata* Cda. on Avena sativa from one host: *a* and *b*, type spores; *c*, *e* and *f*, forms often found; *d*, truncated spore; *g*, two mesospores and a teleutospore from corner of sorus. $\times$ 350.

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Achenia of Coreopsis.

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(WITH PLATE XVI.)

Coreopsis shows as great a variety of achenia as any genus of Compositæ, but they are hard to define. They may be flat or somewhat 4-sided, straight or curved, orbicular to linear-oblong in outline, glabrous to pubescent, winged or wingless, with entire or laciniate-toothed margin, apex truncate or emarginate, pappus of two awns (sometimes more) or of teeth or scales, these generally upwardly hispid (often naked), or all these wanting. The genus is not clearly separated from Bidens, for while the one is said to have its awns always upwardly hispid, and the other downwardly hispid, several species in each hybridize freely and break down this distinction. While the genus possesses such a range of fruit structures, and by this alone one can not always distinguish species as now defined, it enables natural groups of a few species to be easily formed, and most of these can then be separated by leaf characters. In some cases it seems questionable whether these sub-divisions should be made, for they embrace so many intermediate forms that no line can be clearly drawn between them. No attempt has been made in this paper to combine species, with the belief that Dr. Gray in his Synoptical Flora has given the most satisfactory arrangement that can now be made. His lineal order has been followed in

the main, and little variation from his descriptions has been made, except in greater fullness and when new material has brought to light additional characters since the publication, five years ago. So far as I am aware, no attempt has been made to illustrate the achenia of Coreopsis, and this paper is presented with the hope that it will aid botanists in determining the species of this genus, as we all know that a good drawing is scarcely less helpful than the specimen itself.

I have not gone into the troublesome question of nomenclature, although several changes have been suggested. The achenia vary so much sometimes in the same species, or even in the same head, that a single drawing is not sufficient for proper illustration: for example, figures 3 and 4 are from the same head. Other species are quite constant and can be recognized at a glance.

I have consulted the following herbaria in the preparation of this paper, and am indebted to those having them in charge for kindly putting them at my disposal: Private collection of Mr. Wm. M. Canby; Columbia College collection (Dr. Torrey's plants), sent by Dr. N. L. Britton; Wabash College Collection, sent by Prof. John M. Coulter; and the National Herbarium at the Department of Agriculture, in charge of Dr. George Vasey, who has also been a source of help in other ways.

§ 1. Achenia not villous-ciliate, with no callus on inner face, often papillose-roughened.

* Achenia straight, with fimbriately dissected wings, 2 awns, smooth or slightly papillose-roughened.

C. nudata Nutt. Achenia oblong, 1-1½ lines long, smooth; the dissected wings but half as broad as body; awns mostly prominent. (Fig. 1.)

Dr. Gray, in Synopt. Fl., describes the awns as "two short subulate awns," and Torrey & Gray speak of "awns scarcely exceeding the wing of the achenium," while the recent collections of Chapman and Curtiss, from Apalachicola, Fla. (the original station), have awns prominent and exceeding the wing, often appearing more striking than shown in fig. 1. This species seems more closely related to the two following than to C. rosea, which it resembles only in the color of the rays and disk flowers. Thus arranged, we have a group of 3 species differing from every other Coreopsis in their peculiarly dissected wings. The drawing is from Curtiss 1484, collected near Jacksonville, Fla.

C. gladiata Walt. and *C. angustifolia* Ait. are two very closely related species, and many intermediate forms are very puzzling. The achenia do not give very reliable characters, for they vary much even in the same head, and have nothing very constant about them. Fig. 2, perhaps, represents a typical achenium of C. gladiata as considered by Gray in Synopt. Fl., with its short awns and pectinate fringe. Fig. 3 is a good representation of C. angustifolia, with its narrow fimbriate wings and slender setiform awns. Fig. 4 does not look much like the last, but is from the same head near the center. Fig. 5 represents the other extreme, with wing broader than body. The achenia of these species are linear-oblong to obovate-oblong, 1½-2 lines long, smooth or papillose-roughened. Fig. 2 is from J. D. Smith's collection of 1883, near Columbia, S. C. Figs. 3 and 4 are from Dr. A. P. Garber's S. Fla. collection, distributed as C. gladiata. Fig. 5 is from G. McCarthy's collection of the past season, near Augusta, Ga.

C. integrifolia Poir. has been referred to this section, but has never been collected in fruit.

** Achenia incurved, with scarious entire wings, minute awns (except in C. Leavenworthii), smooth to tuberculate-roughened.

C. Leavenworthii Torr. & Gray. Achenia oval, 1 line long: wings as broad as body; awns slender, prominent. (Fig. 6.)

Drawing from Curtiss 1480.

C. Atkinsoniana Dougl. Achenia oblong, 1 line long by ½ line wide, smooth; wings very narrow, often a mere margin; pappus of two small teeth, or obsolete. (Fig. 7.)

Drawing from Howell's collection.

C. cardaminefolia Torr. & Gray. Achenia oval to oblong, 1 to 1½ lines long, smooth or slightly papillose; wings almost as broad as body, sometimes almost as narrow as the preceding; pappus wanting or two very small teeth. (Fig. 8.)

Drawing from Wright's New Mexican collection of 1851.

*** Achenia minute (smallest of the genus), more or less incurved, wingless, awnless, smooth or slightly papillose.

C. tinctoria Nutt. Achenia linear to narrowly oblong, a line or less long, thinnish. (Fig. 9.)

The achenia are much like the following, as shown by the figure. Drawing from Wright's collection of 1849.

C. rosea Nutt. Achenia linear-oblong, less than a line long, thinnish, almost straight, slightly ribbed on inner face. (Fig. 10.)

Drawing from Britton's Long Island collection of 1872. I have transferred C. rosea so as to follow C. tinctoria. Although it has characters which relate it to C. nuda, for our purpose it seems best to consider it in this section. The fruit and habit are so similar that it seems unnatural not to consider it as belonging here.

C. Drummondii Torr. & Gray. Achenia oval to obovate, half a line in diameter, thickish, wingless but with a cartilaginous margin. (Fig. 11.)

The achenia are unlike any others of the genus, but curiously enough the species has been much confused in collections. Drawing from Reverchon's collection, distributed as C. tinctoria.

§ 2. Achenia not villous ciliate, with a large callus generally developed at each end of inner face.

* Wings thin and broad; pappus two small teeth.

C. coronata Hook. Achenia oval, 1 to 2 lines long, smooth or tuberculate; wings from half to as broad as body; pappus two short or prominent teeth. (Figs. 12 and 13.)

Considerable variation is found in the size of the achenia, breadth of wings, and length of pappus. Fig. 12, from Drummond's collection, has the wings narrow, as described by Torrey & Gray; while fig. 13, from Hall's collections, is the more common form.

C. Harveyana Gray I have not seen.

C. grandiflora Nutt., and its two related species *C. lanceolata* L. and *C. pubescens* Ell., can not be separated upon fruit characters with the specimens at hand. Collectors have almost universally neglected to collect them in fruit, and our material has largely been obtained from old collections. Dr. Gray considered that the species were probably confluent, and the nearly identical achenia and similarity of foliage seem to confirm this. Especially is this true of C. grandiflora and C. lanceolata. *C. pubescens* Ell. in the Syn. Flora is said to have (like C. lanceolata) the pappus very small or obsolete (as in fig. 15), but Curtiss 1485 has awns as long as those of C. grandiflora Fig. 14 is C. grandiflora from Bigelow's collections in 1853, Fort Smith, Ark. Fig. 15 is C. pubescens from McCarthy's collection of 1888.

** Wings narrow, involute and very thick; pappus minute or none.

C. auriculata L. is well marked by its achenia, although it resembles C. pubescens very much in its vegetative characters, under which species it was placed by Torrey & Gray. The achenia are very smooth, a line long by half line broad, tuberculate, incurved; wings narrow, involute and thickened, making the achenium boat-shaped. (Fig. 16 *a* and *b*.)

Fig. 16 *a* is the back view of an achenium, and 16 *b* the front view, the inner ring being the thickened involute margin. Drawing from Curtiss's Virginia collection.

§ 3. Achenia oblong, often villous-ciliate, with no callus on inner face, not papillose-roughened.

* Achenia with narrow wings, flat and smooth.

The first five species, belonging to § *Eucorcopsis*, form a closely related group, and though generally easily separated by leaf characters the fruits vary but little. They all have small achenia, which are more or less incurved, with narrow scarious wings and small or obsolete awns.

C. palmata Nutt. Achenia oblong, with narrow wings and obsolete awns. (Fig. 17.)

C. verticillata L. has oblong to obovate-cuneiform achenia with minute awns. (Fig. 18.)

C. delphinifolia Lam. has achenia somewhat broader than the last, from which it can not well be separated upon fruit characters alone. (Fig. 19.)

C. senifolia Michx. is much like the preceding, but the achenia (2 lines long) are not so narrow at base, oblong or elliptical in outline, and awnless. (Fig. 20.)

A specimen collected by Dr. and Mrs. Britton has achenia 2½ lines long and 1½ lines broad. In 1885 the same botanists collected at Black Mt. Station a form which is probably what Elliott described as C. Œmleri, but which Dr. Gray, in Synopt. Flora, considered the "abnormal entire-leaved form" of C. senifolia var. stellata. It does not accord well with the form examined, and seems to approach forms of C. tripteris. The achenia are more oval than in C. senifolia.

C tripteris L. Achenia obovate, broader than the preceding, emarginate at apex. (Fig. 21.)

Drawing from Prof. T. C. Porter's collection of 1868.

** Achenia wingless, somewhat angled, often ciliate on margin.

C. latifolia Michx. is as readily distinguished from its related species by fruit characters as vegetative. Achenia (3

to 4 lines long) narrowed each way from above the middle, the base being narrower than the truncate apex, often stronger ribbed on the outer face, giving a triangular shape, quite glabrous; no awn or pappus of any kind. (Fig. 22.)

Specimens of this species are very rare in collections. The only fruiting specimen found, and from which the drawing was made, was collected by Dr. Gray in 1843. Good specimens are very much desired by the Department of Agriculture.

C. aurea Ait. in its typical form is easily distinguished by its fruit characters, but in some of its varieties approaches the next. Achenia short (1 to 2 lines long), broadly cuneate, slightly pubescent; awns two short broad teeth or wanting. (Fig. 23.)

Drawing from Curtiss' Georgia collection of 1875.

In the var. subintegra, as shown by Chapman's plant (Columbia Coll. Herb.), the awns are longer, acute and spreading and resemble some forms of C. trichosperma. (Fig. 24.)

C. trichosperma Michx. is rather well marked in its fruit characters, although it presents various forms, some approaching C. aristosa on the one hand and C. aurea on the other. Achenia 2 to 4 lines long, a line or less broad, slightly pubescent or glabrous, ovate-oblong to cuneate-oblong; awns broad at base, terminating in a short acumination, erect or turned inward. (Figs. 25 and 26.)

Short's plant from Kentucky and Hall's from Kansas have narrow achenia, approaching certain forms of the next.

*** Achenia very flat, wingless but with thin margins.

C. aristosa Michx. is not easily defined as it grades almost insensibly into several related species on the one hand and crosses so commonly with various species of Bidens on the other. It seems almost impossible to draw any specific or generic lines about it. Achenia very flat, sometimes slightly ribbed on the faces, 3 lines long, oblong to obovate; awns generally quite long, sometimes equalling the achenium and spreading, but in the var. mutica obsolete or nearly so. (Figs. 27 and 28.)

Fig. 31 is from J. Q. A. Fitchey's plant, collected in 1859 at St. Louis, Mo., and considered by Dr. Gray as a hybrid from this species and Bidens chrysanthemoides. Fig. 32 is from a plant collected in 1873 by Dr. F. Brendel of

Peoria, Ill. It is evidently a hybrid from this species and Bidens frondosa. The awns are downwardly barbed, and the marginal hairs upwardly turned, as in B. frondosa, while the rays and leaves are those of C. aristosa.

C. involucrata Nutt. is said to have achenia with two short acute teeth, but was not seen. It is closely related to the last through its variety. Fig. 33 is probably a hybrid from this species and Bidens frondosa, collected by G. H. French in Ill., in 1878.

C. bidentoides Nutt. Achenia linear to narrowly cuneate, 4 to 5 lines long (largest of the genus), with two prominent awns $\frac{1}{2}$ to $\frac{2}{3}$ their length, slightly spreading, and minute awns from the lateral angles. (Fig. 29.)

Dr. Vasey collected near Washington, D. C., Sept. 23, 1888, a peculiar hybrid from this species and Bidens connata, which has the awns of both Coreopsis and Bidens, that is, they are hispid upward or downward or both ways.

C. discoidea Torr. & Gray. Achenia linear-oblong to cuneiform, 2 to 3 lines long; awns more or less prominent, erect or slightly spreading. (Figs. 30 *a* and 30 *b*.)

EXPLANATION OF PLATE XVI.—All drawings ×10. Fig. 1. C. nudata. Fig. 2. C. gladiata. Figs 3, 4, 5. C. angustifolia (the first two from the same head. Fig. 6. C. Leavenworthii. Fig. 7. C. Atkinsonia. Fig. 8. C. cardaminefolia. Fig. 9. C. tinctoria. Fig. 10. C. rosea. Fig. 11. C. Drummondii. Figs. 12, 13. C. coronata. Fig. 14. C. grandiflora. Fig. 15. C. pubescens. Fig. 16*a*, 16*b*. C. auriculata. Fig. 17. C. palmata. Fig. 18. C. verticillata. Fig. 19. C. delphinifolia. Fig. 20. C. senifolia. Fig. 21. C. tripteris. Fig. 22. C. latifolia. Fig. 23. C. aurea. Fig. 24. C. aurea, var. subintegra. Figs. 25, 26. C. trichosperma. Fig. 27. C. aristosa. Fig. 28. C. aristosa, var. mutica. Fig. 29. C. bidentoides. Fig. 30*a*, 30*b*. C. discoidea (from same head). Fig. 31. C. aristosa × Bidens chrysanthemoides. Fig. 32. C. aristosa × Bidens frondosa. Fig. 33. C. involucrata × Bidens frondosa. Figs. 11, 14, 15, 16*b* represent the ventral side; all others show the dorsal.

Department of Agriculture, Washington, D. C.

BRIEFER ARTICLES.

Sensitive stamens in Compositæ.—It is well known that the flowers of several species of Compositæ are sensitive, among the leading of which are the centaureas and thistles. This fact, together with the great similarity of floral structures, has led me to look for movements in other species. Considerable quantities of the flowers to be studied were collected,

placed in a deep glass vessel filled with water, and set where there would be plenty of light and warmth, but to the exclusion of all insects naturally visiting such blossoms. After a few hours a jar was placed upon a table and the flowers inspected for sensitiveness. A large bull's-eye condenser was adjusted upon its tall stand so that a head of flowers came into full view. Then, with the eye intent upon the particular blossom, the various floral parts were touched with the point of a needle.

By this method the first reward was Echinacea angustifolia. In this the whole flower, when touched upon one side, will move in a direction opposite to that of the irritant: that is, if pushed by the needle upon the south side, the top of the flower will move south, and through a distance averaging its own diameter. At the same time there is a contraction or drawing down of the ring of anthers equal to one-half of the diameter. This motion takes place quickly and leaves the lemon-colored pollen exposed upon the tip of the style, which may already extend somewhat above the anther-ring. Unusually good results are obtained with flowers which as yet show no portion of the style. In such the ring will contract and show the first pollen in profusion upon the extremity of the style. After an hour or so the flower again becomes irritable, and the anthers will retreat farther, leaving a fresh supply of pollen exposed upon a lower section of the style. The contraction is such that in many instances there is a revolving motion to the flower, as has often been seen in the thistle. In the Echinacea there are none of the peculiar hairs exhibited by the thistle filament, the surface being smooth throughout.

The observations which have been stated for the Echinacea hold true in a general way for Heliopsis levis, although there are minor differences not worthy our present attention.

A third species to be added to the list of sensitive flowers is Lepachys pinnata, and a fourth is Rudbeckia hirta.

With a good triplet and upon a bright hot day fair results may sometimes be obtained in the field, but as insects are usually abundant the laboratory method is much more satisfactory. The writer would be pleased to learn what other Compositæ have been found in this country illustrating sensitiveness of the stamens.—Byron D. Halsted, *Rutgers College, New Brunswick N. J.* [Mr. Thomas Meehan has investigated this matter at considerable length, but ascribes the movements to elasticity and not sensitiveness. See abstract of his paper in Proc. A. A. A. S., Phila. meeting, papers in Proc. Phila. Acad., and various abstracts and notes in this journal.—Eds.]

Peronospora upon cucumbers.—On May 8th, while taking a run through the greenhouses and grounds of Mr. J. T. Hill here in New Brunswick, my attention was attracted by the numerous light patches upon the leaves of some cucumber vines which were growing in a hot-bed and already bearing fruit suitable for the table. Upon examining these spots they were found to be due to a growth of some species of the genus Per-

onospora. From the fact that *Peronospora australis* Spegaz. grows upon Sicyos angulatus, another member of the cucumber family of plants, one naturally turned to that as given in Ellis' N. A. F. No. 1416 for comparison and verification. The conidiophores and conidia are surprisingly different from the Sicyos species, and the patches of mildew as a natural consequence have a different aspect. Attempts have been made to germinate the conidia, but as yet without success. The oospores have not been met with.

This note is introduced here that students of this destructive group may be upon the watch for the cucumber mildew and its present range determined. From the nature of the fungus, and the plant upon which it is found, it is to be feared that market gardeners may have in the cucumber mildew a serious enemy, especially should it spread to squashes, melons and other members of the Cucurbitaceæ, and attack the seedling plants.—BYRON D. HALSTED, *Rutgers College, New Brunswick, N. J.*

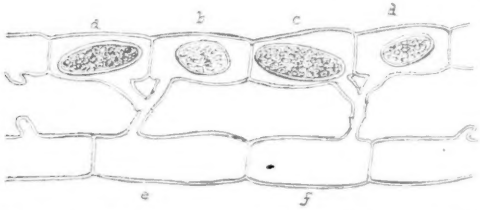
Lactuca Scariola L.—I first noticed this plant in the summer of 1885 in the corner of an abandoned vegetable garden, and in the adjacent street, near my home on 71st street. It has since spread along the street for a couple of blocks, and is well established. I have not seen it elsewhere in the vicinity of Chicago.—E. J. HILL, *Englewood, Ill.*

Aster ptarmicoides, var. **lutescens** Gray.—In the BOTANICAL GAZETTE for 1883 (Vol. VIII, p. 238), an article by me appeared entitled "Aster or Solidago." It was based on a study of some plants found at Englewood nearly like A. ptarmicoides, but with pale yellow flowers. The question was raised whether it might not be a hybrid. This supposition proved to be wrong, for, specimens being sent subsequently to Dr. Gray, he identified it as given above, and it was thus published in the "Synoptical Flora." The article closed with the statement that the plant might throw some light on the *Aster lutescens* of "Torrey and Gray's Flora of North America," which Douglas collected in British America, near the Assiniboine river, as it seemed quite near that species. This conjecture, it seems, turned out to be true.

But the habitat here is at a great distance from that, and I do not learn that it has been found elsewhere in the United States. Macoun (Catalogue of Canadian Plants), under *A. lutescens* Torr. & Gray, states that it grows by the Assiniboine river, on the authority of Douglas, and on his own authority says: "west of the Touchwood Hills, 1872, not detected since." Gray, in the "Synoptical Flora," says, "Red river." But the Assiniboine and Red rivers unite in Manitoba a little before flowing into Winnepeg Lake, so that the region is essentially the same. The Touchwood hills are about 500 miles farther west, near the upper waters of the Assiniboine. I find no mention of its occurrence in other places. In his "Catalogue of the Flora of Minnesota" (1884), Warren Upham, referring to its presence in Northern Illinois, says: "it will probably be found in Minnesota."

It is the rarest of plants here. The locality where it was first seen is now on one of the main business streets of Englewood, and mostly covered with buildings. I afterwards found a few plants about a mile farther south, at Normal Park, and transplanted some of them, as the locality was rapidly passing into the hands of those building residences. But one of these plants is now living, a vigorous specimen, and with rather larger flowers than when planted, as if cultivation agreed with it. I have looked for plants every summer since these were taken up (1886), but so far without finding them. It grows in company with the typical A. ptarmicoides, which is everywhere abundant in the dry grounds here. But the plant in my garden is the only one I know to be existing this side of British America, though I shall still continue the search for it. I should expect the connection of these widely separated localities to be by way of Lakes Michigan and Superior. Several years ago I found a somewhat similar case, an isolated patch of a malvaceous plant, *Sphæralcea rivularis* Torr., on an island of the Kankakee river. Its home is in the far west, "W. Wyoming, northward and westward" (Coulter's Manual of Rocky Mountain Botany). In a notice of this plant, in the "American Journal of Science" (3, vii, 239), Dr. Gray gave his opinion as follows: "Unexpected as the discovery is it is not difficult to see how the species may have got there. A good many northwestern plants occur on the shore of the southern end of Lake Michigan, evidently through water transport. Some of these may have come in recent times, although this could not be inferred simply from the fact that they have not been noticed until lately. Here is one which probably came so long ago as when Lake Michigan discharged into the Mississippi, the lower part of the Kankakee river being in the direct course of the discharge. The present plants may more probably be regarded, not as chance stragglers, but as lingering remnants indicating an ancient habitat." When the Aster was sent, he expressed similar views regarding its presence here.—E. J. HILL, *Englewood, Ill.*

A phase of conjugation in Spirogyra.—The accompanying illustration was made from a camera lucida drawing of a phase of polygamy in Spirogyra longata which was put in alcohol in May, 1888. It completes the history of the phase suggested by Rose's nos. 10, 11 and 12, vol x, page 304, of the GAZETTE.



The contents of *e* seem to have passed into *a* and *b* and a zygospore has been formed in each. That in *a* is larger and darker than the one in *b*. The same is true in *c* and *d*.—C. B. ATWELL, *Evanston, Ill.*

CURRENT LITERATURE.

The Rusts and Smuts.

The rusts (Uredineæ) and smuts (Ustilagineæ) have for a long time been favorite objects for collection and study by botanists. The former, especially, have attracted much attention both on account of their neat and varied spore forms and the readiness with which in general they may be distinguished by the hosts on which they grow. It is significant also that we owe one of the most interesting chapters in the study of the life history of fungi to the economic relation of rusts to agriculture. It is fitting that such well marked and interesting groups should receive independent treatment, and the assertion is abundantly substantiated by a recent work which lies before us. This is Mr. Charles B. Plowright's[1] account of the British species of these two groups, prefaced by a statement of the general conditions of their development and of their experimental cultivation.

There has always been a curious association of the rusts and smuts in the minds both of the pub'ic and of the scientist, although it has not yet been shown that they have any actual relationship that might justify it. Mr. Plowright's book would doubtless have been just as acceptable with the smuts omitted, although cutting out nearly one-fourth the pages and one-half the illustrations, for he has added little to what was already well known about them.

The chief interest of the volume lies in the part on the rusts, and the treatment is so satisfactory as to amply justify the publication in book form. The publisher's part has been well done, if one is inclined to accept the liberal use of heavy paper, wherein we detect a willingness to expand two dollars' worth of matter into a four dollar volume, as is the custom with certain American firms.

Every one of the seventy pages on the biology and experimental treatment of the rusts shows the author's intimate knowledge of his subject gathered from extensive independent research. He tells us of the mycelium, of the several spore forms and their significance, of the remarkable history of heteroecism, and of his own excellent methods of spore culture. This he does concisely and by the use of admirable diction. Any one who is studying, or thinks of studying, these fungi will find this part of the work of unusual interest and importance.

After the biological part, occupying about one-third the book, comes the systematic treatment of the British species. The arrangement of the rusts is essentially that proposed by Schröter, but the position of many

[1] PLOWRIGHT, CHARLES B.—A monograph of the British Uredineæ and Ustilagineæ, with an account of their biology, including the methods of observing the germination of their spores and of their experimental culture. pp. 347, 13 wood cuts and 8 plates. 8vo. London: Kegan Paul, Trench & Co., 1889. 10 s. 6 d.

of the species has been determined by Mr. Plowright's cultures. The biological notes appended to the description of many of the species are particularly important, and give evidence of the author's careful and extensive research.

No more need be said for the illustrations than that they are well executed.

Those familiar with the subject need not be told that this work, owing to the large number of species common to the United States and Great Britain, is almost as serviceable to American botanists as to the English.

A New Text-book of Botany.[2]

This is the day of text-books, and an active botanist seems hardly to have done his duty until he has prepared a text-book, a laboratory guide, or at least a scheme for plant analysis. The book before us is a revised and enlarged edition of the "Elements of Botany," recently published by the same author, and contains "organography, vegetable histology, vegetable physiology and vegetable taxonomy, with a brief account of the succession of plants in geologic time, and a glossary of botanical terms." Attempting, as it does, to cover nearly the whole field of botany, there can be no elaborate discussion. The author has prepared his text with great care, and has brought together in compact shape much that is best in modern botany. If we were inclined to point out defects in this really painstaking book, we would say that the illustrations are not all they might be. Many of them are copies from standard figures, and would have looked better if they had been reproduced by some photographic process rather than redrawn. But this is a minor matter, when the figures are accurate. In the illustration on page 197, however, we have a transverse section of a leaf in which the stomata are shown in surface view, a thing that is apt to be misleading. The book is a useful one and will serve its purpose well.

Minor Notices.

PROF. C. S. SARGENT has done good service to botanists by editing portions of the journal of André Michaux. It is published by the Amer. Philosophical Society in a pamphlet of 145 pages. The editor acknowledges the great assistance rendered by Mr. John H. Redfield, for without it "the publication would never have been begun, and could not have been finished." The journal is more than a diary of travel, for it contains much valuable information concerning the plants discovered, and the condition of remote settlements as an intelligent traveler saw them in the last century.

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[2] BASTIN, EDSON S.—College Botany. 8vo., pp. xv, 451, with nearly 600 illustrations Chicago: G. P. Engelhard & Co., 1889. $3.00.

DR. WM. TRELEASE has published the results of his study of Ilicineæ and Celastraceæ.[3] The paper is intended more as a call for additional information than as a completed synopsis. In Ilex no change of nomenclature is proposed except the reduction of I. myrtifolia to a variety of I. Dahoon. A new species of Euonymus from S. California is described. A notable feature of the paper is that it includes notes on the biology and paleobotany of the groups considered.

ILLUSTRATIONS of West American Oaks, from drawings by the late Dr. A. Kellogg, has just been published in San Francisco. Prof. E. L. Greene has prepared the text, while the funds for this elaborate quarto pamphlet of over 50 pages and 24 plates have been provided by James M. McDonald, Esq. A sketch of the life and work of Dr. Kellogg is given by Mr. George Davidson, while an introductory account of oaks in general is from the pen of Prof. Greene. The work is a most commendable one, and the careful sketches of this difficult group made by an acute observer are better than any amount of verbal description. Professor Greene has also done his work well, and given us a careful account of the bibliography and range of the species. The new species proposed are Q. MacDonaldi, Q. Engelmanni (*Q. oblongifolia* Engelm. in part), and Q. turbinella.

WHAT SHALL constitute a species, is even a more puzzling question among bacteriologists than it is to the phænogamist. Dr. Trelease stated his views on this question recently to the Alumni Association of the St. Louis Medical College, and his address is printed in the *Weekly Medical Review*, xix. 309. Morphological characters, with proper allowances, including the mode of growth in solid cultures and the behavior of the cells towards staining fluids are of prime importance. Physiological characters (such as pigment production, specific fermentation and liquefaction of gelatine) are apparently reliable. Pathogenic characters are too unreliable to render species which depend on them above suspicion.

A VERY interesting address is that from the same gentleman on Myrmecophilism, delivered as retiring president of the Cambridge Entomological Club.[4] The author considers the functions of extra-nuptial nectar-glands, the occasional ant-domiciles on plants, and myrmecophilous plants proper. The paper deals so much with details that it is impossible to summarize it. It is accompanied by a bibliography of the important papers on this subject.

PROFESSOR PENHALLOW has endeavored to bring together in a connected form the more important facts relating to the development of botanical science in Canada.[5] The first 266 years, *i. e.*, from the first

[3] Trans. St. Louis Acad. Science, v, 343-357.

[4] Reprint from Psyche, 1889, pp. 171-180.

[5] PENHALLOW, D. P.—Review of Canadian Botany from the first settlement of New France to the nineteenth century. Part I. From the Trans. Roy. Soc. Can., v. 4, 45-61. 4to. Montreal: Dawson Bros. 1888.

voyage of Jacques Cartier to New France to 1800, was a period of very slow scientific progress, and the names of those who in any way contributed to botanical work in Canada do not exceed 24. Regarding these the author gives much interesting information, with notices of their work. It is evident that it has taken much time and labor to search out these facts, and the thanks of the antiquarian, as well as the historian and botanist, are due to Professor Penhallow.

AN IMPORTANT contribution to the knowledge of the moss-flora of New Guinea forms the last issued part of the Bibliotheca botanica.[6] The collections on which it was based were made by Bäuerlen in 1885 in the south, by Chalmers and Bridge in the Cloudy Mts. in 1884, and by Lawes in the Astrolabe Range. Eighteen new species are characterized and eight figured on the beautiful plates. An appendix enumerates the Hepaticæ of the same collections, including one new species.

CYPRESS "knees" have long been of special interest to morphologists. Dr. W. P. Wilson found favorable opportunity to study these structures while in Florida. A preliminary notice[7] describes two modes of formation, (*a*) by growing upward of young roots till they reach the air and then turning downward again, the knee forming at the angle; (*b*) by local outgrowths from the upper surface of old horizontal roots. Similar ærating organs were caused to form on Indian corn by keeping the soil saturated. They were also observed on Pinus serotina, Nyssa aquatica and Avicennia nitida.

OPEN LETTERS.

Flowers and Insects.

I have been much interested in Mr. Robertson's article on Flowers and Insects. Under Dicentra Cucullaria he refers to observations of others and myself in regard to the puncturing of the corolla by bees. I am pretty sure that the holes were made by honey-bees, as a large hive is in the next yard to mine, and my flowers constantly visited by its occupants. I have observed the same puncturing this year in my yard and that of Mr. George Hunt. It should be stated, however, that Dicentra is not indigenous here, and is only seen in cultivation. In the wild state it may, for all I know, be untouched.

W. W. BAILEY.

Providence, R. I.

The National Herbarium.

In the GAZETTE for April an allusion was made to the National Herbarium, which, perhaps, was not sufficiently definite. An arrangement

[6] GEHEEB, ADELBERT.—Neue Beiträge zur Moosflora Neu-Guinea. Bibl. bot., heft 13. Pp. 12. pl. 8. 4to. Cassel: Theodor Fischer. 1889. M. 10.

[7] WILSON, WM. P.—The production of ærating organs on the roots of swamp and other plants. Proc. Acad. Nat. Sci. Phila. Apr. 2, 1889. 8vo. pp. 3.

was made, some time ago, between the Secretary of Agriculture and the Secretary of the Smithsonian Institution, by which the botanical collections of the Department of Agriculture and the botanical collections of the Smithsonian Institution in the National Museum were practically united to constitute the National Herbarium, and were placed under the care of the botanist of the Department of Agriculture. There is no present transfer of the herbarium of this department, but whenever the Smithsonian Institution secures a new fire-proof building, special provision will be made for bringing the two collections together.

The appropriation for herbarium work has been increased and valuable collections of plants are now being made in various parts of the country. We hope in time to make the herbarium worthy of the name of National. At the same time we hope to form such relations with the agricultural colleges of the country as will be for mutual benefit. We hope also, through exchanges, to enlarge our representation of foreign plants. We shall be glad of the aid of botanists throughout the country in the way of donations or exchanges of desirable plants, especially of those of distant or unexplored sections. GEO. VASEY.

Washington, D. C.

NOTES AND NEWS.

GEO. R. VASEY is collecting in E. Washington Terr. for the Department of Agriculture.

THIS YEAR is the centennial of the introduction of the chrysanthemum into Europe and of the dahlia into England.

AN ENDEAVOR is being made to establish a fund for the promotion of botanical research in memory of the late Dr. Leitgeb of Graz.

A BIOGRAPHICAL sketch of the late Ernst Rudolph von Trautvetter, by F. G. von Herder, has just been published in the *Botanisches Centralblatt*.

A SPECIMEN of Podophyllum has been received from John M. Snider of Dayton, Ohio, which consists of a flowering stem without leaves or leaf scars, and also has the stamens united.

MR. J. REYNOLDS VAIZEY, of Cambridge University, England, a young botanist of much promise, is dead. Some of his best writings appeared in the first volume of the Annals of Botany.

A SHORT ARTICLE on potato scab, giving a resumé of present known facts, is contributed by Prof. Jas. E. Humphrey to the sixth Annual Report of State Agric. Expr. Station at Amherst, Mass.

DR. ANTOINE MOUGEOT, a well-known cryptogamic botanist of France, died February 20, at 74 years of age. He was one of the charter members and the first secretary of the *Société Mycologique de France*.

DR. C. F. MILLSPAUGH is publishing a series of articles on our native medicinal plants in the *Homœopathic Recorder*. The recent numbers contain plates and descriptions of Epiphegus Virginiana and Viburnum Opulus.

DR. SERENO WATSON was elected a member of the National Academy of Sciences at the recent meeting in Washington. The number of members is now one hundred, the limit fixed by the laws of the Academy, although never before attained.

DR. N. L. BRITTON (*Torr. Bull.* May, 1889) has published a preliminary note on the N. American species of *Tissa* Adans., or the sand spurreys, which have heretofore appeared variously as Spergularia, Lepigonum, etc. Ten species are enumerated.

THE ARTICLE by P. H. Dudley on the fungi destructive to wood' printed with the botanist's report in the 41st annual report of the New York Museum, has been translated into French, and appears complete with the illustrations in the *Revue Mycologique* for April.

PROFESSOR THOMAS MEEHAN has just distributed his fourth "Contribution to the life histories of plants." It contains notes on secund inflorescence, Pinus pungens and its allies, Corydalis flavula, dimorphism in Polygoneæ, nature and office of stipules, and Euonymus Japonica.

THE SOCIÉTÉ de Physique et d' Histoire Naturelle of Geneva has offered a prize of 500 francs for the best monograph of a genus or family. The manuscript, which must be written in Latin, German, French or Italian, must be sent to the president by the 1st of October of the present year.

PEACH and apricot stones (endocarp and seed) are used in California for fuel, the former bringing $6 a ton and the latter somewhat less. They were formerly waste products of the great fruit-preserving establishments. Peach stones are considered equal to the best California coal for domestic use.

A BIBLIOGRAPHICAL DIRECTORY of American agricultural scientists has been issued by Prof. C. S. Plumb. It contains over two hundred names chiefly those connected with experiment stations. The work is carefully compiled and neatly printed, and will be of interest and service to those interested in the scientific progress of agricultural knowledge.

THE SACRED LOTUS, Nelumbium speciosum, has become established in a pond in New Jersey, and proves hardy, although the surface of the water is frozen over during the winter. The history of its planting, by E. D. Sturtevant, is given in *Garden and Forest* for April 10, with a fine photo-engraving of the spot showing hundreds of open flowers.

THE WIDE FIELD that still remains for research among the mosses of North America is indicated by a comparison between a recent catalogue of the moss-flora of the neighborhood of Geneva, Switzerland, and the known species of this country. Guinet's catalogue contains 465 species and 114 varieties, while our total of recorded species does not much exceed 1,000.

ZOPF HAS discovered a new species of Saccharomyces which he has named after the most distinguished student of this group S. Hansenii. This yeast, instead of producing alcoholic fermentation, causes the formation of oxalic acid from such various substances as grape, cane and milk sugars, galactose, maltose, dulcite, glycerine and mannite. It forms ascospores after the fashion of S. cerevisiæ, but one or two only.

FOR A LONG TIME attempts have been made to place the control of the Bartram botanic garden of Philadelphia in such hands that its proper protection and care should be assured for all time. It is a precious legacy to botanists and plant lovers, and of special historic interest. On March 7 the Philadelphia Select Council provided for its purchase, and will soon place it under the same management as the other city parks.

THE EXAMINATION of seventeen evergreen and deciduous trees [by L. A. Gulbe] gave the following general result: In spring the activity of the cambium begins in the twigs, passes thence into the stem, then into the thick and lastly into the smaller branches of the root, four to five weeks after its beginning in the twigs. Towards autumn its activity disappears in the same order, but the period of cessation covers two months. In the second half of October it has completely ceased in the roots.—*Bot. Centralblatt*, xxxviii, 487.

A BOTANICAL CONGRESS is to be held in Paris during next August, to which the Botanical Society of France invites foreign botanists. Those who expect to attend should send their names to M. P. Maury, Secretary of the Organizing Committee, 84 Rue de Grenelle, Paris, and obtain further information. Two subjects are especially proposed for consideration: Methods of studying geographical distribution of plants through coöperative action of scientific bodies, and Value of anatomical characters in classification. It is to be hoped that a number of American botanists may be present.

THE NEW French journal, *Revue Général de Botanique*, begins after a most vigorous and promising fashion. The articles which have appeared in the first four numbers are all of importance and by authors of the highest rank. Among the names are those of Rosenvinge, Guignard, Bonnier (the editor), Constantin, Leclerc du Sablon and Jumelle. The reviews of recent works in various departments are an extremely good feature, and very much more readable than the abstracts to which some journals devote themselves. The *Revue* is published by Paul Klincksieck, Rue des Ecoles, 52, Paris.

MRS. E. G. BRITTON begins in the April number of the *Bulletin* of the Torrey Botanical Club a series of papers with the title, Contributions to American Bryology. The first paper is an enumeration of the mosses collected in Kootenai county, Idaho, by Mr. Leiberg. One new species, Hypnum (Thamnium) Leibergii, is described, and also the fruit of Grimmia torquata. In February last, I also had the pleasure of discovering the fruit on specimens of this species sent me by Mr. Leiberg. In the material which came under my observation, the capsules were not infrequently slightly longer than stated by Mrs. Britton (0. 8—1. 2 x 0. 6mm. were my measurements) and a well-developed, persistent annulus, of three (rarely four) rows of cells was found. Mrs. Britton says, "Annulus none."—C. R. B.

AT THE MEETING of the Botanical Society of Munich, held on March 11, R. Hegler proposed the use of thallin sulphate as a new reagent for lignified tissues. All the previously used reagents, phloroglucin, and the salts of anilin, naphtalidin and toluidin are open to the objection that the reactions are transient and involve the use of an acid which is troublesome and requires considerable care. Thallin sulphate, however, obviates the use of an acid and the color it imparts to lignified walls, a deep orange yellow, is permanent. Its action is wholly upon vanillin. It should be used in a concentrated solution in dilute alcohol or in water. The solution should be protected from the light and is better prepared in small quantities as needed. Exposure to light causes the solution to become rose red, when it will impart this color to the cellulose and suberized walls, though the lignin reaction is not interfered with. The longer the action on sections the intenser the color.

SOME CONCLUSIONS of Belajeff as to the constitution of the antherozoids of ferns and equiseta, based upon researches in December, 1888, but just published[1] differ very materially from those of Guignard,[2] though the two observers seem to have seen about the same things. Belajeff says: "In all vascular cryptogams the body of the spermatozoid consists of a colorless band, in which a chromatin-filament or body is enclosed. The development shows that the achromatic band arises from the plasma, the chromatin body from the nucleus of the mother-cell." Guignard: "In the ferns it is again the nucleus alone that is transformed directly into a spiral band; the cilia arise from a peripheral layer, relatively thick, of hyaline protoplasm. * * * The morphological transformation of the nucleus is accompanied by internal modifications which render the spiral band homogeneous and equally chromatic, except in the posterior part where it is colored a little less by the reaction of the nuclein. The very delicate envelope of the body is not formed directly by the protoplasm."

M. GASTON BONNIER has, to our mind at least, completely settled the vexed question of the nature of lichens, by his recent experiments in the synthesis of these organisms. In the first part of the ninth volume of the *Annales* des sciences naturelles (botanique) he explains fully his methods of culture and the results attained.[3] The methods seem as rigid as possible. Stahl's researches in this direction, while of the utmost significance, were open to objection in that they did not exclude sources of possible error, because the cultures were exposed to ordinary air and the sowings were made on unsterilized media. Bonnier has avoided this source of error by carefully sterilizing all his media, culture flasks, implements, etc. Two methods of culture were used, flasks or tubes, and cells. In both cases arrangements were made for the renewal of the air either by the natural currents due to changes of temperature or by artificial means. In both cases germs were excluded by causing the air to pass through cotton plugs. Algæ of known species were collected (their purity demonstrated by microscopic examination) and sowed on pieces of sterilized bark, rocks, etc. Then spores of lichens were sown on the same substratum. Except in one instance, fructifications were obtained within two years. The following is a list of the species grown in this way. In appearance and structure they were like the wild forms: With Protococcus, Physcia parietina, P. stellaris, Parmelia Acetabulum; with Pleurococcus, Lecanora sophodes, L. subfusca, L. coilocarpa, L. cæsio-rufa; with Trentepohlia, Opegrapha vulgata, Graphis elegans, ?Verrucaria muralis.

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[1] Berichte d. deutsch. bot. Gesells. vii. 122.

[2] See this journal, ante, p. 137, and Revue gén. de Bot. i. 71.

[3] Brief reference was made to some of Bonnier's results in this journal, xii. 202. His experiments were begun in 1882 and completed last year.